



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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MEMORANDUM

Subject: Review of Soil Vacuum Extraction Field Test at the Lord-Shope Site

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To: Jim Feeney, Remedial Project Manager (3HW12)
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Thru: Dick Scalf, Chief
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In response to your request for technical assistance, I have reviewed Volume II of the Feasibility Study for the Lord-Shope Landfill. This memorandum represents my initial observations and comments. If necessary, additional input could be provided after the meeting tentatively scheduled for October 18 or 19.

1. Use of "Effective or Lumped" Partition Coefficients in Estimating Remediation Time

The mathematical model (Attachment 3) used to estimate remediation time and residual soil levels assumes local equilibrium and that volatilization is controlled by Henry's constant. The former assumption is commonly used in solute transport models while the later assumption appears unique. In a three-phase system (i.e. soil, water, and air) it is usually assumed that volatilization is a function of both the soil-water partition coefficient and the water-air partition coefficient (i.e. Henry's Constant); otherwise a compound such as PCB-1260 with a dimensionless Henry's constant of 0.3 would be expected to volatilize readily. In a four phase system (i.e. soil, water, air, and oil) the situation can be more complicated. In an initially water-wet system, it is commonly assumed that oil "coats" the soil-water and most of the contaminant is associated with the oil, thus volatilization is controlled by an oil-air partition coefficient. To further complicate the situation, it is likely that at the pore-air velocities typically observed during soil vacuum extraction, that contaminant vapors are not in equilibrium with the surrounding soil, water, and oil. Thus, mass removal can be substantially less than expected. Eckenfelder Inc. noted the discrepancy frequently observed between mass removal predicted from equilibrium conditions and Henry's constants and that observed from laboratory column and field studies. The method that they choose to reconcile this difference is by the use of "effective or

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lumped" soil-air partition coefficients. These parameters are determined from laboratory column tests and then used for model input to determine remediation time.

Problems arise when one attempts to quantitatively describe several processes with one lumped parameter. One primary concern is whether the lumped parameter is suitable for use only under the laboratory conditions in which it was applied, or whether it can be transferred for modeling use in the field. By their definition, partition coefficients should represent contaminant equilibrium in soil, water, and air. "Effective or lumped" partition coefficients used here represent both equilibrium partition coefficients and mass transport rates associated with these coefficients. Thus, "lumped" partition coefficients are accurate only at the laboratory flow rate in which they were measured. This has obvious implications on the predictions for remediation time if air velocities observed in the field are dissimilar to that observed in the laboratory. The flow rate measured in the laboratory columns was 18 ml/min. Assuming an effective porosity of 0.2, this is equal to a pore gas velocity of 1.0 cm/min or 14.4 m/day (47.2 ft/day) which is a fairly rapid pore-air velocity even for vacuum extraction application. Thus, these "lumped" soil-air partition coefficients may represent a conservative bound when considering mass removal on a pore-size scale.

There are other mass transport considerations on a larger scale that one must be cognizant of (e.g. soil aggregates, lenses of fine grain material, and soil horizons) which these laboratory columns and the model did not (in the case of aggregates) or could not incorporate. Mass transport in these instances may be controlled by aqueous and gaseous diffusion. Because of these considerations and other difficulties, I believe that a controlled pilot scale test run for a sufficient period of time in addition to information collected from laboratory columns is necessary to have any chance of predicting residual concentration levels within a specified period of time.

2. Measurement of "Lumped" Partition Coefficients

"Lumped" partition coefficients are presented in Table 4-5 without supporting analytical documentation. Apparently they were derived by comparing contaminant concentrations in soil columns with their corresponding effluent air concentration at some period in time. Were the "lumped partition coefficients determined at 14 days, 34 days or for the time period between 14 and 24 days? This is important since the time of measurement will influence the determination of these coefficients. Also, where is the supporting gaseous analytical data? Were there any duplicate gaseous samples? Was a mass balance completed comparing the initial soil mass minus the mass volatilized with the final contaminant mass in the soil column? How were the gas samples collected? Were tedlar bags used for the column studies as was done in the field? Overall, this laboratory test appears poorly supported. Eckenfelder or the Lord Corporation should provide all data collected during the column test to EPA or PaDER for closer scrutiny.

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3. Representativeness of Soil Samples for Modeling Study

If a sample is disturbed during collection as was the case during this study, the aggregate structure of the soil sample will be altered. This is important when considering mass transport limitations due to aqueous or gaseous diffusion from soil aggregates. If possible, it is preferable to collect relatively undisturbed samples. The nature in which the samples were collected (i.e. hand augers) and prepared for laboratory experimentation may have facilitated mass removal thus giving a false impression of vacuum efficiency.

Table 3-2 on page 13 indicates that substantial concentrations of 1,2-dichloroethylene (1,2-DCE), trichloroethylene (TCE), xylene, and toluene (EP 8) were detected during extraction well effluent sampling. Initial analysis of soil in EP 7 and 8 illustrated on Table 4-1 on pages 17 through 20 indicate that TCE, 1,2-DCE, and toluene were not detected in soil samples. Since an extraction well draws in vapors from a much larger volume of soil than that directly surrounding the screened interval of the well, an extraction well gaseous sample does not necessarily have to be representative of the soils immediately surrounding the well. However, the discrepancy explained above indicates that the samples collected from EP 7 and 8 are at least not representative in contaminant identification in the "crested" soil area.

The actual concentration of contaminants in the landfill toe and crested soil area is also of concern. Soil samples were composited over 3.5 to 4 feet. If discrete samples were obtained every foot, observed soil concentrations could have been significantly higher. Probably more important, especially in the crested soil area, is that samples were only collected to a depth of 5.5 to 6 feet. Since depth to ground water is approximately 25 feet in this area it is possible that contaminant concentrations could have been substantially different with depth. Also, the distribution of the volatile organic compounds in soil may not be constant with depth and area. In some areas, contaminants may be present in a soil, water, air, product form instead of a soil, water, air form which would impact the efficiency of enhanced volatilization.

4. Data from Manometers

Figure 2-1 illustrates the locations of two manometers (M-1 and M-2). Was any data collected from these manometers? What is the justification for their location? At what depth are they monitoring?

5. Length of Tests

It is mentioned on page 11 that the ISVS system was run for three hours at EP 9 and then moved to each of the extraction probes outside the capped area. Was the ISVS system run on the other extraction wells for the same period of time?

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6. Purpose of ISVS Tests?

I am confused as to what the purpose of the ISVB tests were. On page 14, it is stated that the wells were tested to "see how much material can be extracted using the portable ISVS unit". There is no information provided on the propagation of vacuum from the extraction wells, thus air conductivity could not be inferred. No evidence is provided in the tests to indicate the possibility of meeting a performance standard. All the modeling is based on soil samples. The tests were too short-term and without adequate monitoring to demonstrate anything of importance.

7. Boring Logs

The boring logs in Attachment 1 are without any soil textural information. Any report suggesting or proposing the use of soil vacuum extraction to remediate soils should contain at least minimal information on soil texture and permeability.

8. Use of Tedlar gas sampling bags

On page 11, it states that vapor samples were collected from the extraction probes into 1 liter Tedlar gas sampling bags. The limitations of using Tedlar bags were recently discussed at a Soil Vacuum Extraction Workshop at RSKERL. Researches in academia and industry (API) generally do not use Tedlar bags because of demonstrated significant VOC loss. VOCs easily diffuse through teflon since it is a permeable material. Recent research at RSKERL and by others has demonstrated that air diffuses through sampling and connection lines made of teflon. It is recommended that steel canisters or tenax tubes be used in lieu of Tedlar bags for sample storage.

9. Remediation of Landfill Area

The feasibility of applying soil vacuum extraction to remediate "soil" within the landfill was not addressed except to say that the "heterogeneous" nature of the fill precluded a laboratory scale study, therefore mathematical modeling could not be conducted. The material within the landfill is apparently crushed drums and drum fragments. Thus there exists the possibility that highly contaminated residue is still "semi-contained" and will be released over time. I recommend that vacuum extraction proceed within the landfilled area to substantially reduce vapor concentrations. After this has accomplished, section of the cap should be removed to allow test pitting into the landfill to observe the condition of large scale "heterogeneities" (i.e. drums). If semi-contained waste still exists, the cap should be removed, and all drums excavated for offsite disposal. Soil vacuum extraction could then be allowed to proceed to completion. If drums containing waste material is not removed, soil vacuum extraction could continue indefinitely.

10. Lowering of the Water Table

Apparently some of the waste material within the landfill intersects the water table. Also, it is likely that aquifer sediment near the water table is highly contaminated. I recommend that when boreholes are drill for extraction well installation that continuous cores be collected through

the water table to determine the contaminant distribution sorbed on aquifer sediment with depth. It may be much quicker and less expensive to lower the water table and apply vacuum extraction to an increased vadose zone than to pursue pump and treating.

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